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A NATURALIST'S YEAR.

By GRANT ALLEN.

XV.—CONCERNING BATS.

WHAT a number of wild animals we possess in England whose very existence hardly ever obtrudes itself upon us, even though they may have taken up their residence in the self-same houses which we conceited human beings vainly presume to call our own. For example, there are the bats. They say no less than fourteen distinct species of these queer, night-flying creatures have been found in Britain, and yet how seldom anybody ever notices them, save by the merest chance—certainly far too casually to venture upon pronouncing a definite opinion on the obscure question of their specific distinctness. In the garret of this very house, now, between the outer tiles and the plaster ceiling, a whole colony of the long-eared kind—commonest but one, I should say, among the British species—has taken up its permanent quarters. We are but five "humans" in precarious possession of the premises, but when we first came here we found the bats already firmly settled on the spot, ranged up from the rafters by dozens, and hanging head downward by their hooked claws from the edges of the cross-beams or other timbers. Recognising their just prescriptive claim against uncompensated disturbance, we have left them still strictly as tenants *in capite*; and every summer night about half past nine, they issue forth from the attic air-hole, to sweep the garden far and wide in search of moths and other nocturnal insects. During the winter, however, they lay by quietly in cosy crannies between the tiles, hibernating after the fashion of most smaller British mammals, and living on the store of fat which they have duly accumulated on their own plump bodies in the lavish abundance of the flush season.

Bats are, perhaps, the oddest and most abnormal of all mammals, with their very developed wing-like membranes, and their extraordinary power of extended flight. Yet it is not very difficult to trace by analogy the steps through which they have acquired their existing organs of locomotion. True, the great central group of mammals from which they appear to be descended—the insectivores, or shrew and mole group—are particularly wanting in anything approaching the possession of flight; they are thoroughgoing ground animals, most of them burrowers, and all of them averse to climbing, which seems invariably the first step towards the acquisition of wings, or their equivalent. This, however, is doubtless due to the very fact that their more advanced and developed descendants, the bats, have cut them out in this respect, so that all the intermediate and less perfect types have long since become extinct. But the various half-flying creatures which we meet with elsewhere, though not themselves at all connected genetically (save, perhaps, in one case) with the bats or the insectivores, still help us to understand by analogy the origin of the bat tribe from an ordinary insectivorous ancestor. It is well known that among forestine animals a great tendency exists towards the production of a rudimentary flying apparatus; and there is hardly any great group of mammals among which the more tree-haunting members have not begun to develop such a mechanism, in a more or less perfect form. Anybody who has ever watched even our English squirrels, leaping lightly from bough to bough, can readily understand how closely their movements approximate to the rudest type of flight; for in these familiar creatures, which have as yet no specialised membrane for the purpose, there is some faint approach towards the use of a parachute, as they always spread out their legs, head, and bushy tail to the utmost extent in taking what is characteristically described as "a flying leap." But among some of their relations, the whole class of flying squirrels, comprising a number of American and Asiatic forms, there has been developed a distinct extensible membrane or fold of skin, spreading from the fore-legs to the hind-legs, and employed as a parachute to break the creature's fall, or to permit it to glide obliquely from one bough to another at a lower level. Naturally, the possession of such a membrane gives an arboreal animal a great advantage in the struggle for existence, and hence it is frequently found, independently developed over and over again, amongst all great tribes of tree-haunting animals. For example, among the rodents themselves, there is another group besides the flying-squirrels in which the same peculiarity appears under similar circumstances, and that is in the African family of the anomalures—a family closely resembling the flying-squirrels in outer appearance, but differing from them in so many points of internal structure that they must be looked upon as distinct in origin, and owing their external similarity rather to likeness of circumstances than to identity of genealogical descent. They help, in fact, to prove the universal rule, that nearly the same conditions produce everywhere nearly the same results.

Among the marsupials, or pouched animals, again, the very arboreal family of the Phalangers has produced several so-called flying species, one of which is even known locally in Australia as the flying squirrel, though, of course, it is not really connected in any way with the true rodent squirrels. Nevertheless, the resemblance in the bushy tail, the long, loose, flying membrane, and the whole shape of the head and body, is so close as to be almost ridiculous. Finally, there is one very strange creature—half lemur and half insectivore, the colugo or galeopithecus—which seems like an actual remnant of the ancestral line by which at least one great group of bats—the fruit-bats of the East—were originally evolved. This curious beast, a surviving representative of some very ancient type, differs from most other parachute-bearing mammals, in the fact that the space between its fingers is "webbed," or covered with skin, a great approximation to the

character of the bats. If, as many naturalists believe, the fruit-bats are really a separately-developed class by themselves, then it is not impossible that the galeopithecus may represent one of the intermediate steps in their original development; for the fruit-bats seem to present strong points of affinity to the lemurs, whose region they inhabit, and to be, in fact, specialised lemuroid animals, while the other bats appear rather to be highly advanced and winged insectivores.

The flying squirrels and even the galeopithecus cannot really fly in the strictest sense of the word; they can only glide sideways and downward by means of a skin parachute. In the true bats, however, the organ of flight has attained a far greater development than this; for they are able to rise and wheel about in the air with the same freedom and facility as birds. To make this possible, the fore-arms and the finger-bones have attained in them an immense development, the middle finger especially being ordinarily as long as the whole body, without the tail. Between these fingers, and from them to the hind legs, stretches the membrane by means of which the bat flies. It is the great length of the fingers, and the extent of membrane between them, that enables the bat to fly in the true sense; and yet, it is impossible to compare the skeleton of a bat with the skeleton of a shrew, and not to perceive at once that the bat is really in all essentials a flying shrew. The bones of the fore-legs (or arms) are all prodigiously lengthened, out of all proportion to the rest of the body; but that is all. In ground-plan the two animals resemble one another very closely. With the light thrown upon the subject by the flying squirrels and galeopithecus, it is not difficult to understand how a race of ancestral tree-haunting insectivores may have taken to pursuing their prey in the air as they jumped, and how this habit would give an advantage to such animals as possessed very slight extensile patches of skin to buoy them up from falling too rapidly. Thus we would first get a creature like the colugo, and then, as the animals took wider and wider excursions after their insect prey, the possession of longer fingers and webbed hands would begin to tell in favour of any chance divergent individual. In this way, from generation to generation, the most bat-like insectivores of such a type would most frequently survive, until at last the whole group became evolved into true bats by the necessary extinction of its least advanced members. Once fully developed, the race would begin to diverge afresh in different directions, and so to give us all the immense variety of existing bats. Geologically, we know that these flying mammals go back to a comparatively early age, and when we first find them in the eocene deposits they have already acquired the full marks of existing families: hence we may conclude that they must have diverged from the insectivores while that group was still young and plastic, and that their fossil pedigree is now lost for us in the mist of ages.

THE *Railway Age* (Chicago, May 3) says that narrow-gauge trains have been blown off the rails in California on several occasions lately during tornadoes.

BURNHAM BEECHES.—Mr. F. G. Heath is issuing at the office of *Forestry* a special "Author's Edition" of his little work, "Burnham Beeches," to which will be prefixed a facsimile of the long and interesting letter of Lord Beaconsfield to the author on peasant life, trees and sylvan scenery—a letter particularly referring to Burnham Beeches, and written a short time only before the late Earl's death.

"SOCIABLE" TRICYCLES.

BY JOHN BROWNING.

(*Chairman and Treasurer of the London Tricycle Club.*)

THAT delusions die hard is proverbial, but two in connection with "Sociable" tricycles have, I trust, received their death-blow this week. The first is, or was, that "Sociable" tricycles are very much slower than single machines. The second, that these double tricycles must weigh from 170 lb. to 180 lb. to be safe. I am aware that many makers now quote the weight of their "Sociables" as between 140 lb. and 150 lb., but in every instance that I have been able to weigh them, save one—Singer's "Apollo"—they have scaled upwards of 170 lb.

To test the qualifications of the "Sociables," I recently proposed to the committee of the London Tricycle Club to give two £3. 3s. prizes to the winners of a twenty-five mile road ride on "Sociables," to be competed for by members of the Club.

The committee not only accepted my offer, but very handsomely supplemented it by subscribing themselves £3. 3s. as a second prize. There were six or seven entries, but, from various causes, only four pairs of riders were able to start at the appointed time.

The ride was twelve and a half miles out and back to the starting-point, on the same road, the course being from near Caterham Junction, over Merstham Hill and Red Hill, on the road to Crawley, and returning. The effects of hills and wind were, therefore, to a great extent, neutralised. The roads were very rough, inches deep with dust, and plentifully strewn with loose flints, the result of the dry weather which has recently prevailed. The atmosphere was heavy and humid, and most unfavourable to exertion.

Under these circumstances the ride was completed in the following times:—

1st riders	...	2 hrs	1	min.	30	secs.
2nd ,,	...	2 ,,	6	,,	5	,,
3rd ,,	...	2 ,,	7	,,	25	,,
4th ,,	...	2 ,,	19	,,	0	,,

It will be seen at once that the distance was covered at the rate of between twelve and thirteen miles an hour, which will compare favourably with the performance of single tricycles, and not badly with that of bicycles.

But a still more important point to note is this—that the winners, Messrs. Howard and Salmon, rode a specially light machine, made for them by Hurst, of Croydon. This machine must have been at least 40 lb. lighter than that ridden by Messrs. Nixon and Bates, who gained the second prize, and I think it most probable that if the riders were to change the machines and ride such a race again, the second men would be in nine or ten minutes ahead, instead of being between four and five minutes behind the late winners.

Yet the fact that the light machine stood the test of being driven over rough roads for twenty-five miles at a racing pace is sufficient proof that it is amply strong for ordinary riding or touring.

Riders of medium weight should now insist on machines built specially for them being made much lighter, though heavy riders would do well to study strength in preference to lightness.

Perhaps the greatest advantage of a lighter "Sociable" would be found when it became necessary to push it up an unrideable hill. Where there is one lady riding with a gentleman, the gentleman has, of course, to push the machine up hills by himself. When touring with my wife, I find the lighter "Apollo Sociable," which Singers have

recently made me, a much easier machine to push up hill than any I have tried previously.

During the next season I trust we shall see "Sociable" tricycles in the market which will be nearer 100 lb. in weight than 200 lb., and, eventually, I have little doubt that their weight when required for light riders may be reduced below 100 lb. Single tricycles are now made of various patterns — for instance, the "Humber," the "Monarch," and the "Coventry"—which do not exceed 65 lb. in weight, and yet are strong enough for all ordinary work; and a double tricycle need not certainly weigh so much as two single tricycles. The elder Starley, the creator of the tricycle, who, being a very heavy man himself, always erred on the side of weight, only began by making his "Sociable" weight 180 when the single weighed 110 lb.

To reduce the weight of the "Sociable" the machine must have smaller wheels.

To make the machines as light as they well can be, the wheels should not be more than 40 inches in diameter. For average riders these might be geared level, but for strong riders they would be better geared to 45 in. One great advantage of a machine with 40 in. wheels is that it can be put into a guard's van and carried anywhere in a train. A machine with larger wheels requires a truck, and is charged at carriage rates.

The performance of "Sociable" tricycles will, however, not be satisfactory until they are provided with two-speed gearing. It is common on such machines to ride with some friend, either a lady or gentleman, who, from want of practice, can do but little towards propelling the machine. Under such circumstances, a head wind, rising ground, or a rough road will soon nearly stop the riders. Two-speed gearing would then be invaluable. A machine with 40-inch wheels should, for average riders, be geared down to 30 inches for power for all hard work, and up to 50 inches for speed. For strong riders, who wish to travel as fast as possible, the power gear should be 35 inches and the speed gear 55 inches.

The following makers are already prepared to supply machines with two-speed gearing. The St. George's Foundry Company, Bricknell & Co., the makers of the "Merlin," and Burdess, who is known as the ingenious contriver of the "Sterling" and "Rucker," and Singer, are preparing to supply such gearing.

Lloyd Bros., the maker of the novel and excellent rear-steerer, the "Quadrant," are making for me a two-speed machine on an entirely new plan. The readers of KNOWLEDGE shall be informed as to the details and the performance of this machine directly I have tried it.

A subscriber of KNOWLEDGE has asked me to repeat my warning to tyros not to deviate from a straight course to avoid either stones or ruts when running quickly down a steep hill. Such a deviation is most dangerous. Should it incautiously be made, the error cannot safely be corrected by using the steering handle only. The brake should be *carefully, not suddenly, applied at the same time*, and it will be found more beneficial in steadying the course of the machine than it is in checking it. This use of the break is not known as it should be.

Before I found out the advantage to be gained by using the break in this manner, I had two very ugly accidents; but of late I have experimented on all kinds of uncertain rear-steering machines with safety. Had it not been for the use I have constantly made of the break in the manner described, I doubt if I should be tricycling now.

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THE ORIGIN OF WHALES.*

BY RICHARD A. PROCTOR.

THE capture of a bottle-nosed dolphin, which is now disporting itself in a tank at the Brighton Aquarium, synchronises rather happily with Professor Flowers's suggestive lecture on whales at the Royal Institution—a lecture bringing out very effectively some of the most remarkable evidence in favour of the modern theory of biological evolution. The idea prevails that this theory depends in large degree on the resemblances existing between different forms of animal life. It is supposed, for instance, that because men and monkeys, and horses and sheep are all backboned animals, therefore science recognises relationship among these various classes of animals. In reality, the modern theory of development does not depend at all—whatever may have been the case with older theories—on mere features of resemblance in structures and in organs manifestly useful. It might be reasonably said in answer to any argument of the sort that the special arrangements which are good for one class of animals, are not, therefore, necessarily bad for another class, but may be the best for that class also. The antecedent probability would seem to be that certain types would be found to prevail among animals even if the structure of each order had been made a matter of special teleological arrangement. The resemblance between the handles of a screw-driver, a chisel, and a gouge, does not show that these instruments have either been developed one from another, or that they have all been developed from a common form; bnt arises from the simple circumstance that that form of handle is convenient for the work which all these instruments are intended to do. But as a matter of fact, the modern theory of biological evolution depends rather on the differences than on the resemblances between races presumed to be more or less akin, is based rather on the partial disappearance of structures or organs in particular races—or rather on the way in which such partial disappearance is found to have been brought about—than on the existence of the same sets of structures or organs in different animals. For the absence, or almost total absence of a structure or organ in any animal is proof that the animal can do very well without it, and does not need it; so that an organ found to be practically wanting is one for which nature manifestly had no occasion to make provision; and if it is found that, nevertheless, nature *has* made provision for some such organ, which yet has not come to its full development, or remains practically non-existent, then there is strong evidence in favour of natural development or evolution, as distinguished from special creative acts. For instance, the presence of the bones of the fore-arm in man affords scarcely any reason for regarding him as akin to the monkey, the horse, the sheep, all of which also have the same bones; for the fore-arm is obviously as useful to man, though not in the same way, as it is to those other animals; but the presence of tail-bones in the human skeleton indicates kinship, because man needs no tail either for prehensile purposes, as with certain classes of monkeys, or to sweep away annoying insects, as with the horse. If such kinship were not rendered probable by the actual structure of the tail bones, with the rudiments of parts, such as in lower animals have useful purposes, it would be rendered so by the embryological evidence, which shows how the rudimentary tail in each human being began with relatively important proportions, and with accessories suggestive of future usefulness in more ways than

* From the *Newcastle Weekly Chronicle*.

one. To say that special creative acts might well have fashioned all animals on one general plan, if that plan were the best, is reasonable enough; but it seems altogether unreasonable to say that there would probably, or even that there might possibly, have been such a rigid adherence to one plan that those animals which had no use or occasion for certain organs, would yet be provided with the rudiments of them, and in the beginning of their existence would have them in relatively full development.

The study of such an animal as the whale illustrates this line of argument with singular force. For scarcely any animal possesses so many rudimentary organs as the whale. Thus the whale wants no teeth, yet in the beginning of its existence it has teeth. It has no use for separate fingers, or, therefore, for the muscles which move the fingers; yet it has fingers, immovable—because enclosed in an unyielding integument—yet provided with muscles. It wants no hind limbs (at any rate, it gets along very well without any); yet not only has it rudimentary hind limbs, deep buried in its body, but in these can be traced many details of structure such as are found in quadrupeds. (zoologists, by the way, nearly always speak of the whale as a quadruped). Regarding the structure of each animal as a matter arranged originally by special creative acts, such characteristics as these are more than perplexing: they are clearly suggestive of imperfection of plan and variability of purpose. But regarded as the evolutionist regards them, they indicate the perfection and widely-ranging character of the law by which, as surroundings change, animals change in character along with them. Although the idea of Deity must ever transcend (and transcend infinitely) the thoughts of man, there seems something infinitely nobler in the conception of a lawgiver whose laws take into account the occasion for change and provide for them, than in that of a workman restricted to a particular plan, and rather fashioning useless mechanism on that plan than departing from it as occasion arose. To use an illustration drawn from manufacture, we recognise wisdom in the gradual progression from the heavier vehicles of former days, when roads were bad, to the lighter carriages of our own time; whereas, when we note that the peculiarities of the old stage-coach were repeated—quite uselessly—in the first forms of railway carriages, even to the reproduction of features having no meaning in railway travelling, we recognise simply the absence of inventive faculty. Yet there are those who are absolutely offended with science for showing that throughout nature there is evidence of wisdom of the former type, though infinitely wider in scope, and *no* evidence of that want of inventive faculty which would have been suggested by the uniform application of one and the same plan under varying conditions.

Apart from such considerations as these, the theory of biological evolution applied to different classes of animals affords evidence such as we can obtain in no other way respecting their past history. Thus, while palæontology affords very little information respecting the past history of the cetaceans, the rudimentary organs throw some light on the question. It appears, says Professor Flowers, "that originally whales were land mammals of fairly high organisation, with a hairy covering, and complete olfactory apparatus for smelling in air, teeth of several kinds, and distinct fore and hind limbs." "Whales," he adds, "are not related to animals like seals, as if the hind limbs had been developed into very efficient aquatic organs. It is not easy to imagine how these limbs could have become completely atrophied, and their function transferred to the tail. More probably whales were derived from animals with tails which were used in swimming, like those of the beaver, and eventually with such effect that the hind limbs became no longer necessary." The whale, judged by its anatomical structure, seems more closely related to pig-like animals than to any of the carnivora. The absence of any traces of cetaceans in the cretaceous strata has long been noticed as a remarkable circumstance. Professor Flowers finds a probable explanation in the fact that many existing species belong exclusively to rivers, whence we may perhaps infer that the whole group had a fluviatile origin. It would be interesting to inquire what was the probable origin of the plesiosaurus, ichthyosaurus, and other such sea saurians, whose place the cetaceans are supposed by some palæontologists to have taken. It has long been commonly assumed that the former have necessarily disappeared, but if we consider the circumstances under which the cetaceans probably took their present position, it does not seem easy to recognise any reason for supposing that the saurians would have been dispossessed by the cetaceans. It seems exceedingly probable that if they still exist they might yet scarcely ever be seen. Some accounts of what has been called the sea serpent agree well, as Gosse and other naturalists have shown, with the theory that sea saurians still exist.

THE CHEMISTRY OF COOKERY.

XII.

By W. Mattieu Williams.

RETURNING to the question suggested by my last paper, Why has Rumford's roaster fallen into disuse, notwithstanding the fact, mentioned in his essay, that Mr. Hopkins, of Greek-street, Soho, had sold above 200, and others were making them?

Those of my readers who have had practical experience in using hot air or in superheating steam, will doubtless have already detected a weak point in the "blowpipes." When iron pipes are heated to redness, or thereabouts, and a blast of air or steam passes through them, they work admirably for awhile, but presently the pipe gives way, for iron is a combustible substance, and burns slowly when heated and supplied with abundant oxygen, either by means of air or water, the latter being decomposed, its hydrogen set free, while its oxygen combines with the iron and reduces it to friable oxide. Rumford does not appear to have understood this, or he would have made his blowpipes of fire-clay or other refractory non-oxydizable material.

The records of the Great Seal Office contain specifications of hundreds of ingenious inventions that have failed most vexatiously from this defect; and I could tell of joint-stock companies that have been "floated" to carry out inventions involving the use of heated air or superheated steam that have worked beautifully and with apparent economy while the shares were in the market, and then collapsed just when the calls were paid up, the cost of renewal of superheaters and hot-air chambers having worse than annulled the economy of working fuel described in the prospectus. Thus a vessel driven by heated air, as a substitute for steam, was fitted up with its caloric engine, and crossed the Atlantic with passengers on board. The voyage practically demonstrated a great saving of coal; patent rights were purchased accordingly for a very large amount, and shares went up buoyantly until the oxidation of the great air chamber proved that the engine burned iron as well as coal at a ruinous cost.

Although no mention is made by Rumford of such destruction of the blowpipes, he was evidently conscious of the costliness of his original roaster, as he describes another which may be economically substituted for it. This has an air chamber formed by bringing the body of the oven door so as to enclose the space occupied by the blowpipes shown in Fig. 1, and placing the dripping-pan on a false bottom joined to the front face of the roaster just below the door, but not extending quite to the back. An adjustible register door opens at the front into this air chamber, and when this is opened the air passes along from front to back under the false bottom, and rises behind to an outlet pipe like that shown at *v* Fig. 1. In thus passing along the hot bottom of the oven the air is heated, but not so greatly as by the blowpipes, which being surrounded by the flame on all sides, are heated above as well as below, and the air in passing through them is much more exposed to heat than in passing through the air-chamber.

To increase the heat transmitted in the latter, Rumford proposes that "a certain quantity of iron wire, in loose coils, or of iron turnings, be put into the air chamber."

This modification he called a "roasting oven," to distinguish it from the first described, the "roaster." He states that the roasting oven is not quite so effective as the roaster, but from its greater cheapness may be largely used. This anticipation has been realised. The modern "kitchener," which, in so many forms is gradually and steadily supplanting the ancient open range, is an apparatus in which roasting in the open air before a fire is superseded by roasting in a closed chamber or roasting oven. Having made three removals within the last twelve years, each preceded by a tedious amount of house-hunting, I have seen a great many kitchens of newly-built houses, and find that about 90 per cent. of these have closed kitcheners, and only about 10 per cent. are fitted with open ranges of the old pattern. Bottle-jacks, like smoke-jacks and spits, are gradually falling into disuse.

When these kitcheners were first introduced, a great point was made by the manufacturer of the distinction between the roasting and the baking oven; the first being provided with a special apparatus for effecting ventilation by devices more of less resembling that in Rumford's roasting oven. Gradually these degenerated into mere shams, and now in the best kitcheners even a pretence to ventilation is abandoned. Having reasoned out my own theory of the conditions demanded for perfect roasting some time ago (about 1860, when I lectured on "Household Philosophy" to a class of ladies at the Birmingham and Midland Institute), I have watched the gradual disappearance of these concessions to popular prejudice with some interest, as they show how practical experience has confirmed this theory, which, as already expounded, is that *the meat should be cooked by the action of radiant heat, projected towards it from all sides, while it is immersed in an atmosphere saturated with its own vapours.*

Herein I diverge from my teacher, as the preceding description of both his roaster and roasting-oven shows. His explanation of the prejudice of Englishmen against baked meats may have been to some extent justified by his own experience, seeing that he heated his ovens by a fire placed below, and if he first used these without his water-pan, they doubtless effected the decomposition of the dripping and gravy of which he speaks (see No. XL of this series, page 342); but even in this case the flavour of merely burnt fat is not very serious—far less objectionable than that of the vile mixture of vapours described in No. X.

The few domestic fireplace ovens that existed in Rumford's time were clumsily heated by raking some of the fire from the grate into a space left below the oven. Those of the best modern kitcheners are heated by flues going round them, generally starting from the top, which thus attains the highest temperature. The radiation from this does the "browning" for which Rumford's blowpipes were designed.

According to my view of the philosophy of roasting, this browning, or the application of the highest temperature, should take place at the beginning rather than the end of the process, in order that a crust of firmly coagulated albumen may surround the joint and retain the juices of the meat. All that is necessary to obtain this effect in a sufficient degree is to raise the roasting oven to its full temperature before the meat is put in. Supposing an equal fire is maintained all the while, this initial temperature will exceed that of the continuing temperature, because, when the meat is in the oven, the radiant heat from its sides are intercepted by the joint and doing work upon it; heat cannot do work without a corresponding fall of temperature. While the oven is empty the radiations from each side cross the open space to reinforce the temperature of the other sides.

Is there, then, any difference at all between roasting and baking? There is. In roasting, the temperature, after the first start, is maintained about uniformly throughout; while in baking by the old-fashioned method, the temperature continually declines from the beginning to the end of the process; but in order that a dweller in cities, or the cook of an ordinary town household, may understand this difference, some explanation is necessary. The old-fashioned oven, such as was generally used in Rumford's time, and is still used in country houses and by old-fashioned bakers, was an arched cavity of brick with a flat brick floor. This cavity is closed by a suitable door, which in its primitive, and perhaps its best form, was a flat tile that was pressed against the opening and luted round with clay. Such ovens were, and still are, heated by simply spreading on the brick floor a sufficient quantity of wood—preferably well-dried twigs; these, being lighted, raise the temperature of the arched roof to a glowing heat, and that of the floor in a somewhat lower degree. When this heating is completed (the judgment of which constitutes the chief element of skill in thus baking) the embers are carefully brushed out from the floor, the loaves, &c., inserted by means of a flat battledore with a long handle, called a "peel," and the door closed and firmly luted round, not to be opened until the operation is complete. Baked clay is an excellent radiator, and therefore the surface of bricks forming the arched roof of the oven radiates vigorously upon its contents below, which are thus heated at top by radiation from the roof, and at bottom by direct contact with the floor of the oven. The difference between the compact bottom crust, and the darker bubble-bearing top crust of an ordinary loaf is thus explained.

As the baking of a large joint of meat is a longer operation than the baking of bread, there is another reason besides that already given for the inferiority of meat when baked in a baker's oven constructed on this principle. The slow cooling-down must tend to produce a flabbiness and insipidity similar to that of the roast meat which is served at restaurants where a joint remains "in cut" for two or three hours. Of this I speak theoretically, not having had an opportunity of tasting a joint that has been cooked in a brick oven of the construction above described, but have observed the advantage of maintaining a steady heat throughout the process of roasting in the iron oven of a kitchener, or American stove, or gas oven.

XUM

LAWS OF BRIGHTNESS.

IV.

By Richard A. Proctor.

BEFORE passing to the consideration of the total brightness of globes when viewed so as to present various phases, I propose to make a few remarks on a difficulty which may suggest itself as respects what I said in my last paper about the brightness of an illuminated hemisphere viewed directly. It seems at first sight that such a hemisphere, having a larger surface than a disc of equal diameter, ought to send to the observer at least as much light, notwithstanding the obliquity of the illumination near the edge of the hemisphere. This reasoning really amounts to the supposition that the relative faintness of the illumination of a part near the edge of the hemisphere is compensated by the greater area. Thus, if F E be a small circular cylinder intersecting the surface of the hemisphere in the ellipse M L (Fig. 8) the illumination being

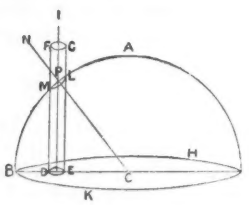

Fig. 8.

received in direction I P; it seems as though the faint illumination of L M should be made up by the greater area of L M, compared with the area of the small circle D E in the case of an illuminated disc as H K. As a matter of fact, the large area L M receives the same amount of light precisely as the small area D E; but it sends it away in a different manner. D E gives back most light in direction P I; but L M sends out most light in direction P N. As seen from that direction the space L M appears as an oval, having a much larger area than D E as seen (from the same distance) in the direction I P. It is obvious, therefore, that M L, viewed in the direction P I, in which it does not give out its maximum amount of light, cannot look so bright as D E (which receives exactly the same amount of light) viewed in the same direction P I, in which it gives out its maximum amount of light.

Or we may view the matter in this way. The hemisphere receives precisely the same amount of light as a disc of equal diameter. But the light received from the disc grows less and less down to *nothing* as the disc is viewed at a smaller and smaller angle from the right angle down to zero (when the disc is viewed sideways). But the light received from the hemisphere, though it also is reduced as the illuminated hemisphere is viewed more obliquely, is nevertheless not reduced to *nothing* when the hemisphere is viewed sideways, for then the hemisphere appears as a half disc of light. The light is not reduced absolutely to zero until the exactly opposite hemisphere is looked at directly. Now, neither the disc nor the hemisphere can give out more light than they receive, and they receive the same quantity of light; hence, since the hemisphere gives out light over a greater range as respects direction, this must be compensated by the circumstance that in that particular direction in which both the hemisphere and the disc give out the maximum of light, the disc gives out more light than the hemisphere.

I have failed, after some trying, to find any method by which the total brilliancy of an illuminated sphere, when presenting any given phase, can be determined so that the general reader can follow the demonstration. Perhaps some of our mathematical contributors may be able to solve the problem in a geometrical way. My analytical solution is given below.* The result, which was long ago obtained by Lambert (I do not know in what way), may be conveniently presented as follows:—

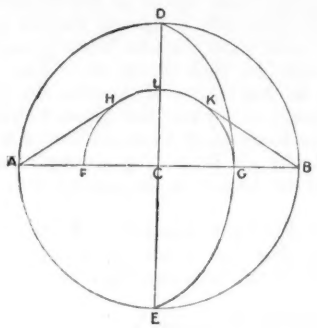

Fig. 9.

Let A D B E (Fig. 9) be a smooth sphere illuminated by a distant body, and let the length of the semicircular arc A D B be taken to represent the total light received from this sphere when A D B E is the illuminated hemisphere. Then, when D G E is the terminator and D G E A illuminated, the total light is represented by the length of the mixed line A H K G, obtained by describing the semicircular arc F L G with C G as radius, and drawing thereto the tangent A H; and when D G E is the terminator, but D G E B illuminated, the total light is represented by the length of the line K B, diminished by the length of the circular arc K G. It follows that when D C E is the terminator, or the sphere "half full," the

* Let A O D Q, Fig. 10, be the illuminated portion of a smooth disc, and let the arc D E (or the circular measure of the angle D O E) = α. Let B be the centre of the illuminated hemisphere, so that B D is an arc of 90°. Let R and S be two points in O Q, such that C S = x, R S = δx, and let two planes, at right angles to

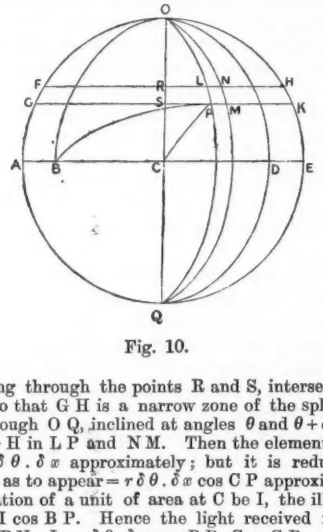

Fig. 10.

O Q and passing through the points R and S, intersect the sphere in F H, G K, so that G H is a narrow zone of the sphere; and let two planes through O Q, inclined at angles θ and $\theta + \delta\theta$ to O D Q, cut the zone G H in L P and N M. Then the elementary area P N is equal to $r\,\delta\theta\,.\,\delta x$ approximately; but it is reduced by foreshortening, so as to appear = $r\,\delta\theta\,.\,\delta x$ cos C P approximately. And if the illumination of a unit of area at C be I, the illumination at P is equal to I cos B P. Hence the light received from the elementary area P N = I. $r\,.\,\delta\theta\,.\,\delta x$ cos B P. Cos C P approximately.

light is represented by the length of the line A C; that is—

light of full sphere : light of half sphere
:: arc A D B : A C
:: π : 1
or :: 22 : 7 approximately.

Thus two half spheres do not give the same light as one full sphere; but less, in the ratio of the diameter of a circle to half the circumference.

Again, it is easy to compare the sum of the light given in two phases supplementary to each other, as D G E A and D G E B, with the light of full sphere. For we have light of D G E A : light of full sphere :: A H + H K G : arc A D B. Light of D G E B : light of full sphere :: B K − K G : arc A D B. Hence (remembering that A H = B K) we have light of D G E A + D G E B : light of full sphere :: A H K B : A D B.

AUSTRALIAN ANTS.

THE kind of ants perhaps the best knows near Melbourne are those generally found in paddocks, parks, and other pasture lands. In up-country districts the space of ground covered by the so-called nests are often of enormous proportions. I noticed one, some years since, on the eastern side of the Wodonga Railway, near Benalla, that must have been fully ten yards in breadth and length, so that the area thereof would be nearly 1,000 square feet. These nests are perfect hives of industry, the population outnumbering in all probability that of many European capitals. A mere glance at the surface, however, gives but very little idea of the amount of living creatures belonging to and labouring for the commonwealth. A slight disturbance of the community, either by scraping with the foot or thrusting a blade of grass down one or the other of the numerous entrances, is sufficient to bring out the underground population in countless numbers, and he who thus disturbs the peace of the republic is fortunate if he escapes with less than a few score of the warriors and sentinels clinging to his garments and biting the flesh when arriving at an uncovered part with ferocious energy. I am not aware whether there are galleries underground uniting the several entrance shafts with each other or not. The probability seems to be that each hole at the surface leads only to one nest, altogether independent of all the rest. To decide this point two tests were resorted to. A small stick was forced gently into one hole, the usual outrush following, as might be expected. The other entrances, even when only removed a few inches from the one experimented upon, were used for the purposes of exits and entrances as ordinarily was the case, and there was no excitement whatever. The second test consisted in blowing the smoke of a cigar or pipe down one hole, and then watching the rest. As may be supposed, the little inmates of the hole subjected to temporary fumigation issued from the same in crowds. No smoke, however, escaped from any of the other holes, nor was there ever any alarm manifested thereat. This is by no means the case with ants of some other species, many of whom are in the habit of building large nests with many entrances. Smoke blown into any given hole of such nests escapes from other holes, not unseldom at several feet distance. A very marked peculiarity with respect to this kind of ant is the number of roads constructed by them, and leading in all directions to the foraging ground. Such roads may often be traced for several hundred yards. They run radially from the nest, and, at certain distances, are bifurcated, or split off into branches. These roads are altogether cleared of obstruction, every root of grass being as carefully cut down (if the life in it is not absolutely destroyed by some occult means), as is a line through the forest denuded of timber by the surveyor as preparatory to the construction of a new highway. The only obstacles left are stones and a few fast-growing plants, which are seemingly beyond the power of the little workers to clear away. The road, therefore, is made to deviate a little from its ordinary straight line, resuming the same line as soon as the obstacle has been passed. As may be supposed, owing to the numerous branches, the road is most thronged with passengers near the nest, so that it appears almost as crowded as does Cheapside or the Strand on a fine afternoon. There is, however, but little jostling, and no lingering crowds; there are no loiterers in such a community, while those passing to and fro appear to keep sides as rigidly as do well-informed pedestrians on a metropolitan pavement. Occasionally the roads cross a bush-track or macadamised roadway. In such cases it is generally resumed on the opposite side. Under ordinary circumstances, the string of ants is preserved unbroken completely over the bare space. A passing vehicle, however, as does a strong breeze, by removing the dust, generally breaks up the string, the little animals running about and spreading themselves in all directions—evidently at a loss by which way they should proceed.

This following in regular file and over considerable distances is adopted also by most ants which are of gregarious habits. A small black species is very common in Melbourne, and may be seen running across the pavements, always in the same direction. When the track leads over asphalte, to my eyes the surface appears to be somewhat discoloured. I at first thought the apparent darker shade of the track might be due to fancy and an optical illusion. I have noticed, however, that after a sharp shower the marking referred to is not noticeable until some few hours, during which a constant traffic has been going on, have intervened. A stick or finger drawn once or twice across the track seems to puzzle the passengers above measure, since they are seen to pause and scatter themselves both to the right and left for several inches, sometimes to the extent of one or two feet. From these facts, which have been for a long time observed and commented upon by naturalists, it is inferred that ants are guided by scent, the forerunners leaving an odour behind them which those in the rear subsequently follow. With respect to this theory, however, I have often noticed what is worthy of being recorded. In rushing about to recover the missing trail, one or two—sometimes a

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Now, each of the spherical triangles O B P, O C P is quadrantal, and therefore

$$\cos \text{B P} = \sin \text{O P} . \cos \text{B O P} = \frac{\sqrt{r^2 - x^2}}{r} \sin \theta.$$

$$\cos \text{C P} = \sin \text{O P} . \cos \text{C O P} = \frac{\sqrt{r^2 - x^2}}{r} \sin (\alpha + \theta).$$

Hence, proceeding to the limit and making summation, we get the total light from A O D Q

$$= \frac{\text{I}}{r} \int_{-r}^{+r} \int_{0}^{\pi - x} \sqrt{r^2 - x^2} \sin \theta . \ \sin (\alpha + \theta) \, dx . d\theta.$$

$$= \frac{\text{I}}{2r} \int_{-r}^{+r} \int_{0}^{\pi - \alpha} \sqrt{r^2 - x^2} \, [\cos \alpha - \cos (x + 2\theta)] \, dx . d\theta.$$

$$= \frac{\text{I}}{2r} \left\{ (\ -\alpha) \cos \alpha + \sin \alpha \right\} \int_{-r}^{+r} \sqrt{r^2 - x^2} \, dx.$$

$$= \text{I} . \frac{\pi r}{2} \left\{ (\pi - \alpha) \ \cos \alpha + \sin \alpha \right\} ; \text{ or varies as}$$

$[\sin \alpha + (\pi - \alpha) \cos \alpha]$; or as $\sin v + v \cos v$, if we put $(\pi - \alpha) = v$.

XUM

dozen—would straggle completely across the stick or finger-mark. It generally happened that these chance regainers of the opposite and broken track were not followed, the confusion remaining on either side as great as ever. After a shorter or longer interval an ant would find its way over, and was immediately followed by a rush of the before utterly disorganised crowd. This kind of behaviour would seem to indicate the existence and recognition of duly appointed leaders, and an authority not to be disregarded by the general throng, who refuse to accept of the guidance of any of the common lot.

In digging up some of these nests, one or two remarkable features were brought to light. The queens are generally found huddled together, as if in a sort of seraglio. The eggs and pupæ are similarly gathered in heaps. The usual size of these ants is about a quarter of an inch long; but by opening the nest other members of the community are met with of double such length and of corresponding breadth and thickness. These giants are not so numerous as are the smaller kind, and are seldom seen above ground, and when the nest is dug up they look somewhat like a score or two of Bonnors among a concourse of Bannermans. Such comparative Goliaths are met with in the nests of several of the ant species. The idea entertained by many is that they act as soldiers to defend the settlement. This view, however, so far as my own observations go, does not seem to be verified. They are more than ordinarily sluggish in their movements; they scarcely ever rush out, bent on bellicose operations, when the nest is disturbed, whilst ants not one quarter of their length, and consequently not one sixty-fourth of their bulk, appear to attack them with impunity, the attacking party, if it happens to be a strife of two to one, generally coming off victorious.

Another kind of ant, somewhat larger than the last, of a reddish colour, and by no means so active as those just described, is often common on light, gravelly soil. They are tolerably numerous in the Government House reserve, especially at spots a little removed from the most-frequented pathways. There are seldom more than some half-dozen entrances to the community, and these would seem to be all connected together, as when smoke, as before mentioned, was blown down one hole, it issued, in a short time, from all the rest, the entire settlement appearing to be simultaneously alarmed. This species has its giants also, and has besides a singular habit, as it would seem, of constructing regular sepulchres for the deposit of the dead. I have several times dug up one of these burial-places, which may be said to be extra-mural, since they are generally situate at least at the very boundaries of the colony. The same habit seems to follow these ants when kept in close captivity. A few months ago I placed some two or three hundred within a shallow box covered with a plate of glass and containing a small, artificial glass nest. As the outer box was allowed to stand exposed to the sun, the earth within it dried, and a severe mortality among the inmates was the result. The corpses were all removed and piled up in a heap as far as possible from the entrance to the glass nest. I several times scattered the bodies so heaped together, but they were invariably re-collected by the ants and piled up as before, and always in the same spot. This went on till every member of the community had died but one. It is only fair to add that the sole survivor seemed to hold an opinion that the rights of sepulture should be rigidly attended to, and observed, since they were accorded by the solitary individual, last of his tribe, to his dead comrades.

> "The skeletons of antdom were around that lonely one;
> Some had expired in fight, though brands
> Were grasped not fast in bony hands."

At last the survivor died also. As none of his race remained to give him decent burial, I dropped him gently on the pile of his late companions, saying, I almost think, while doing so, "Well done, thou good and faithful servant. *Requiescat in pace.*"

(To be continued.)

A SURVEY of the extensive landslip which recently occurred at Warden, in the Isle of Sheppey, shows, says the *Engineer*, that fully three acres of land have sunk from their natural level some 70 ft. down. Had not Warden Church been pulled down three or four years ago, it would inevitably have formed part of the slip. As it is, the entire churchyard has been carried away, and is now located about half way down the cliff. Although each decade shows a greatly diminished acreage in the Island of Sheppey, no attempt is made to construct works to resist the inroads of the sea; it is not worth it. Within living memory, the lane now abruptly cut off once ran on for nearly half a mile, where now the tide covers the foreshore. Beyond the church was a coastguard station, and some ten or fifteen acres of land, all of which have fallen a prey to the encroachments of the sea. A landslip of such magnitude as the present has seldom been recorded.

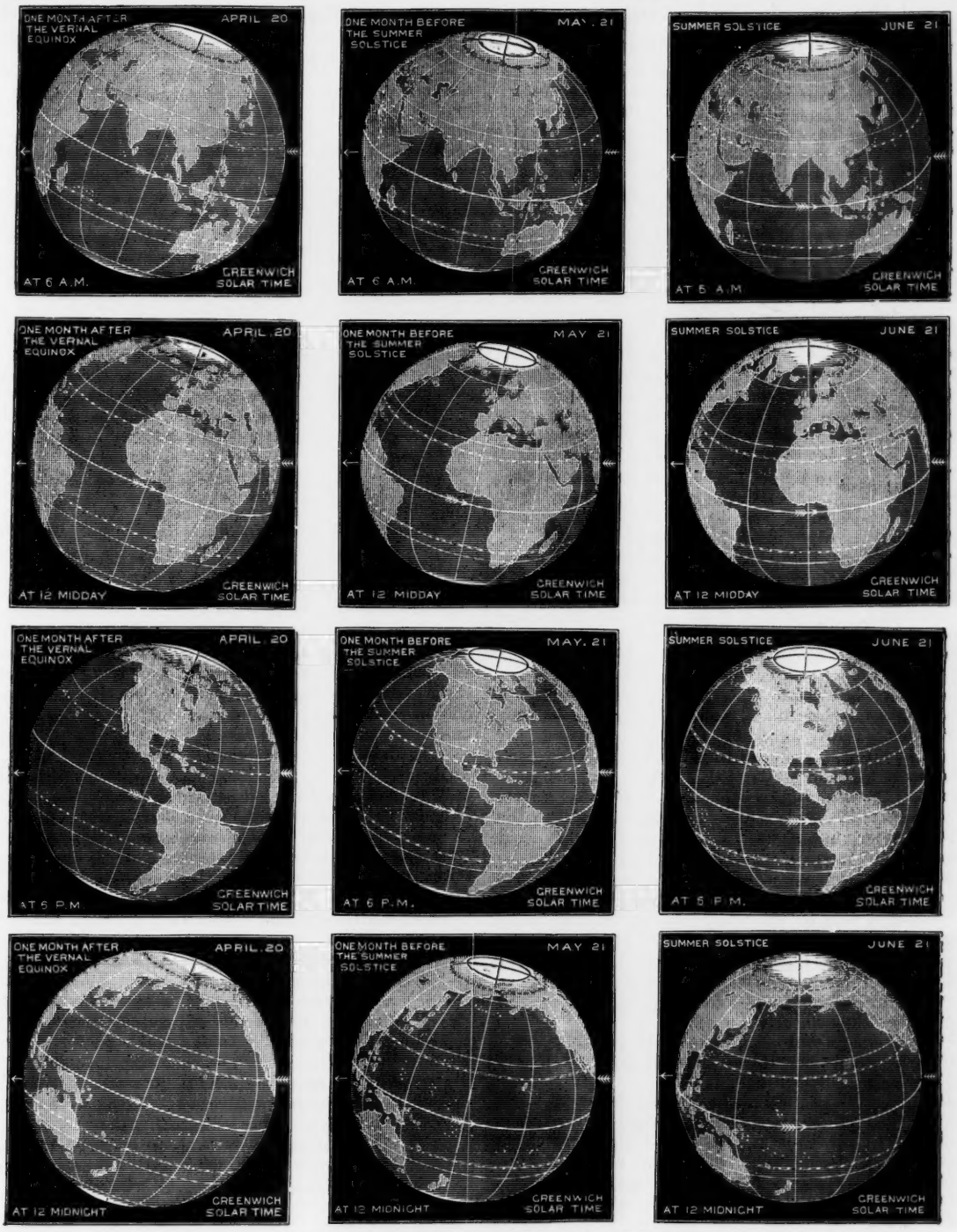
ACCORDING to the last annual report of her Majesty's Inspectors of Explosives, laid before Parliament, there were in Great Britain at the end of the year 1881—Factories, 86; magazines, 317; stores, 2,045; registered premises, 15,669; total, 18,117.

MEXICAN TIN.—The first ton of Mexican tin has, it is said, been lately received in the United States. It came from the Durango district, near the mountains of the same name, and is said to be bright, clear, and of good texture. It was discovered by Mr. Hans Freeman, of Australia, who has for more than a year being searching for evidence of the tin lodes and placers spoken of by the old Spanish settlers.

THE *National Car-Builder* for May mentions that the Vandalia Railway Company are removing the iron wheels from carriages run through with express trains, and replacing them by a 43-in. paper wheels. The same company two years ago issued an order, making the use of the coupling-stick obligatory, on pain of dismissal. Since then, no man obeying the order has been injured while making couplings.

THE *Colonies and India* says trains running on Feb. 13, between Waverley and Nukumara, half way to Wanganui, New Zealand, were brought to a standstill through countless thousands of caterpillars being on the rails. The officials had to sweep and sand the metals before the trains could proceed.

A DESPATCH from Greensburg, Pa., 3rd ult., says:—"The Lyons run gas well recently developed has turned out to be a wonderful affair. The roar of the escaping gas is something terrific, and the amount of gas going to waste is enormous. It is estimated 6,000,000 cubic feet is daily wasted. The well is conceded by all who have seen it to exceed in power the old Murraysville well and the new wells of Messrs. Bolton & Doubleday and Pugh & Emerson's, all three put together. The new well is two and a-half miles nearer Pittsburgh than the Murraysville wells. Messrs. Bolton & Doubleday, imitating the example of boys on a fish pond, have bought an acre close by the new well, and will put down a well in the hope of securing some of the gas of Messrs. Brunot & Haymaker's well. Twenty thousand dollars have been offered for the new well."



SUN VIEWS OF THE EARTH;

OR, "THE SEASONS ILLUSTRATED."

By Richard A. Proctor.

WE give this week the Sun Views of the Earth for Midsummer, in company with those for the last two months, in order that the changing aspects of the earth, as supposed to be viewed from the sun, may be recognised. We leave till next week the pictures showing the aspect of Great Britain, &c., at mid-day in Midsummer. We shall show then, for comparison, the same portion of the earth as supposed to be seen from the earth, at mid-day in spring and autumn, and also at 6 in the morning, and 6 in the evening, in midsummer.

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LIMITS OF TELESCOPES.

IT startles most people to be told they never see the stars, and yet in an important sense this is quite true. The human eye, or a telescope, forms an optical image with the light rays received from the stars, but not a *picture*. The stars are too far off for their light to bring to us the smallest visible representation of their surface, and the discs which a well-corrected telescope shows are only optical images. If, on a clear, calm night, when the air is steady, a telescope is pointed at a planet, it forms a real picture, though the distance of the object prevents details, even of considerable size, from being seen. If, after using an eye-piece that magnifies fifty times linear, another of double that power is employed, the planet's disc will look twice as broad. Try the same experiments with a bright star, and if the air is clear, and quiet enough to produce no confusion, the star disc will not be made bigger by the higher power. Larger telescopes, if good, show stars with lesser discs than smaller instruments, and hence a 6-in. telescope will plainly separate double stars so close that a 3-in. cannot divide them at all. Looking at the moon with an 18-in. telescope and a power of 200, shows more details than the same magnification can display with a 6-in. or 8-in. It is only on rare occasions, and in very favourable situations, that large telescopes can be used effectively with magnifying powers proportioned to their size. The larger they are, the more disturbed air they look through; and it often happens that, instead of showing large stars with neatly-rounded discs, they exhibit them like luminous flags fluttering in a strong wind. Mr. C. Wolff, writing in *Ciel et Terre*, says that Signor Schiaparelli, of the Milan Observatory, can, with a telescope by Merz, with an aperture (diameter of object-glass) of $0^m \cdot 218$, or about $8\frac{1}{2}$ inches, see an object on Mars like Jutland, Cuba, or the Isthmus of Panama. The Washington telescope, of $25\frac{1}{2}$ inches aperture, he states, would distinguish a round object on the moon of about 344 yards in diameter, or an elongated one of half that breadth. He observes, "We are far from the promises made by Arago, when he asked the Chamber of Deputies for a credit for a telescope of $0^m \cdot 38$ (about 15 inches) aperture. He thought, by forcing the magnification to 6,000, a round object on the moon about $65\frac{1}{2}$ feet square, or a long object about $6\frac{1}{2}$ feet wide, might be seen. He considered only the difficulty of obtaining images bright enough for such magnification; but Foucault showed that great apertures were necessary for such purposes, and that to reach the limits mentioned by Arago, a telescope must have an object-glass or mirror nearly 10 mètres (about 33 feet) in diameter. "If," says Mr. Wolff, "we could make such instruments, they would be nearly useless." They would be hindered from working properly by the disturbances of the air.

It is probable that large telescopes will be set up in the best climates that can be discovered for affording clear, steady vision; but if a locality could be found in which the moon could be continuously observed with a magnification of 2,000, that would only be like bringing the eye of the observer within about 170 miles of our satellite, and the planets, being so much further off, could only exhibit objects of very considerable dimensions.

We give the above statements as made by Mr. Wolff, but precise explanations and observations are needed to settle such questions. For example, what is to be called "seeing a lunar object"? One telescope shows a small spot, without details; a larger one exhibits in that spot a little hollow; a still larger some roughnesses in the hollow. Would Mr. Wolff consider the object seen by the first instrument?

Editorial Gossip.

IN the Pavilion at Brighton the use of the oxy-hydrogen lantern has, of late, been forbidden—a restriction rather inconvenient for lecturers. It would, probably, pay well to build a hall in Brighton capable of holding as many as the Dome, with good acoustic properties (those of the Dome are singularly bad), and with sensible arrangements in lieu of the unwise ones in vogue at the Pavilion. The charge for the Dome is higher than would be just for as large a hall of first-rate proportions, and with the best modern improvements.

LOOKING over some of the later editions of Dickens's works, I have been struck by the way in which some of the rules apparently in vogue among compositors have made nonsense of his words. Thus, it appears to be a rule that the word "however" shall always be closely guarded by commas. In the "Charles Dickens' Edition" of "Great Expectations" this rule comes in effectively to improve the conversation between Pip and Magwitch. Dickens made Pip say, "Still, however you have found me out, you have found me out," &c., and a little later Magwitch says, "However you have found me out, you seys jest now. Well! however did I find you out?" Of these three "howevers," the two first are, of course, provided with a sequent comma, making both sentences absurd. The third escapes; wonderful to relate. True, the absurdity would have been even wilder if that third "however" had had its comma. But, "says the ghost, says he, vy that's no rule," on the contrary, that was a *raison de plus* for adding the preposterous comma. In more editions than one, by the way, of the same story we find the absurdity, "'His wish were' said Joe—— as I would, and you that,'"—for "His wish were as I would 'and you that."

ONE of my own favourite *bêtes noirs* in this line is the constant custom of adding a comma after "and" in sentences beginning "And therefore," or the like. Imagine reading or speaking with a pause after the "and" in such cases! Of course the sense is impaired as well as the sound; but the sound should be a sufficient guide.

THROWING in a comma before "which" often produces a most absurd change in the meaning of a sentence, while the sound in reading is not impaired, so that in correcting proofs one is apt to overlook the change. For instance, speaking of the crescent phase, I wrote, "We recognise this peculiarity in the planets which travel nearer to the sun than our earth does." This does not read better (or worse) than "We recognise this peculiarity in the planets, which travel nearer to the sun than our earth does;" but it happens to be a trifle nearer the truth.

THE valuable series of papers on the "Moon," by our esteemed contributor, "F.R.A.S.," must for a time, which we trust may be short, be suspended.

REFERRING apparently to eclipse expeditions and the theoretical views which they either have or have not confirmed, the *Glasgow Herald* (in a review of my "Light Science for Leisure Hours") has the following impressive passage,

("Which is pretty, but I don't know what it means.")

"There was bound to be a little too much shouting over realisations out of those unknown regions, and there will

always be a felt want of a check from the other side, to put it so, in quests that cannot be called Utopian, but that are particularly fit to take away the reproach of idleness from men who may not have a forced field for their efforts." The same review remarks that Mr. Proctor's "disciples may not be tired by his prelections, but the public are sometimes resentful of the assumption of too easy understandings even by great men." In a neighbouring review, obviously from the same Miggsian mind, comes the remark that "wits may jump together without damage to originalities." In glancing over a series of reviews of legal, scientific, and historic works, travel, poetry, fiction, and so forth, by one unable to write respectable English, one is disposed to suggest, that "There is bound to be a little too much outcry over evolutions out of moral consciousnesses, and there will always be a felt want of a check from the other side (other, to put it so, than the cheque calculated at half-a-crown per thirty lines), in decisions which cannot be called judicial, but that are particularly fit to suggest the reproach of impertinence in the case of men who have emphatically forced fields for their exertions."

SAYS the *Eastbourne Chronicle*:—"By his lectures on astronomy, delivered in different cities and towns of the kingdom, Mr. Richard A. Proctor has no doubt done much to popularise this most interesting and elevating of sciences. But, like many modern astronomers who have dived deep into the mysteries of the heavens, Mr. Proctor lays himself open to the grave charge of endeavouring to account for the present aspect of the universe by the mere lapse of time. The existing condition of our planet is put forward as a momentary phase in a development which presupposes thousands of centuries in the past and thousands yet to come. The earth, we are told, was once a gaseous mass, in time it condensed and cooled, and in due course became the abode of life. Now, in the stage of mid-life, Mr. Proctor points to the period—I am afraid to say how many years hence—when it shall pass, like the moon, into the fifth stage of a planet's life—the stage of death—and turn on its axis as slowly as does the 'pale orb of night.' The 'birth and death of worlds' is a sensational way of conveying the idea of commencement and end, but it is an idea necessitating the dealing with ages, and myriads of ages, in a way that is absolutely perplexing. One is dazzled, almost dazed, by the endless heaping up of centuries, and all to account for a condition of things which is far more simply and satisfactorily explained by the plain Biblical narrative of the creation of the world. To make 'time' a universal factor in the economy of the universe is to underrate and limit creative power. This searching after a crude and ill-defined beginning for our earth and for the other planets seems to smatter of the Darwinian theory of the origin of man. Surely the globe we inhabit could as easily have been called into existence in the 'developed' form in which we find it as in a condition less perfect and mature; and why must the moon needs have been at one time a planet presenting the same conditions of life as our earth? All these are mere fanciful suggestions which would be much better left out of lectures of this sort. I would not wish to do Mr. Proctor an injustice, but his ideas respecting the birth and death of worlds fit in very indifferently with Scriptural teaching as contained in the opening chapters of Genesis."

To this the wiser *Eastbourne Gazette* makes answer:—"The *Chronicle* is troubled because Mr. Proctor, the popular lecturer, asserts the earth to be somewhat older than his primary education had led him to believe, and 'fits in very indifferently with Scriptural teaching as contained in the opening chapters of Genesis,' and, moreover, savours of Darwinism. Mr. Proctor's theories do not bear out the popular idea that the earth is only some 6,000 years old. 'One is dazzled and dazed,' says the *Chronicle*, 'by the endless heaping of centuries,' &c. The immense distance of the heavenly bodies does not seem to trouble the writer, it is the *time* that concerns him, because that is not in accordance with Scripture, and therefore he suggests a ready-made world instead of a gradually 'developed' one. All the different strata with their fossiliferous remains, indicating a regular order of growth and development, are to be accounted for by 'miracle.' The coal-beds were always coal, and not submerged forests, and the extinct animals, known only by their fossil remains, never inhabited the earth, but were created as fossils, and all the evidences of prehistoric man are to be accounted for in the same way. If all these proofs of the antiquity of the earth are to be explained as suggested, a gigantic deception has been practised on mankind. But the facts of astronomy and geology cannot be set aside to uphold a view of things that originated in a barbaric age."

FROM San Francisco the following telegram has been received respecting the total solar eclipse of May 6th:—"The solar eclipse on the 6th ult. was very successfully observed by the English, American, and Continental astronomers stationed on Caroline Island, the sky being beautifully clear at the time. The corona extended over a distance of two diameters from the sun. The light during the middle of totality was equal to that of the full moon. Successful observations were made by Dr. Janssen as well as by Professor Tacchini. The intra-Mercurial planet Vulcan was not seen by M. Palisa. The D line of the spectrum was seen dark in the corona by Dr. C. S. Hastings. Good photographs of the corona were obtained by the English observers as well as by Dr. Janssen. The English observers were also successful in obtaining photographs of the flash. Good photographs were taken of the coronal spectrum in the blue end." From other sources we learn that few prominences were seen. We shall discuss the results next week.

THE "flash" in the above means the spectrum of multitudinous bright lines seen for a second or two just after totality has begun and just before it ceases. The word may do very well, coarsely prosaic though it is, for telegraphic purposes; but we see it with regret used in an article in the *Times*, as a fit word for describing one of the most beautiful phenomena connected with a total solar eclipse.

THE same article propounds the truly preposterous idea that the absence of prominences may have indicated that practically the lower part of the corona was itself made up of them.

I REGRET very much that any amount of inuendo should have induced Mr. Irving Bishop to have anything whatever to say to a wager connected with a matter which should be dealt with only by the usual methods of scientific inquiry. The *Times*, with customary Philistinism, describes the wager as a test of the genuine English sort,—implying that the Saxon way of dealing with scientific questions is essentially horsey and vulgar. I have never yet heard of any student of science who has offered to back his opinion on a scientific question by a wager, or by the proffer of a sum to any one who could prove the opinion

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incorrect. I can recall only one instance before the present one, in which a wager proffered by an unscientific man was accepted by a student of science—as Mr. Irving Bishop claims to be, and may continue to be regarded, if he diligently eschews all future use of the wager-test.

IT is amusing to note the singular mixture of scepticism and simplicity in the newspaper comments on the general question of thought-reading. Those who utterly deny that the strange psychical power exists, or can exist, which purely scientific men like Dr. Carpenter have recognised as a proper subject for experimental research, proclaim loudly, in the same breath, the absurd doctrine that if the power exists it is miraculous. The real fact is, that while Professors Barrett, Balfour Stewart, and others have gone far to prove that the power exists, not only is there nothing miraculous (though much that is marvellous) in it, but it actually affords a natural explanation of several phenomena which have been regarded by inexperienced persons as miraculous.

WHETHER Mr. Labouchere's money was lost or not is a question beneath notice here. Sporting papers may settle that point if they like.

OUR Whist Column has been discontinued during the Chess Tournament. It will be resumed next week, or the week after at latest.

THE number of miles of streets which contains mains constantly charged, and upon which hydrants for fire purposes could at once be fixed, in each district of the metropolis, is now as follows:—Kent, 85 miles; New River, 214; East London, 120; Southwark and Vauxhall, 119; West Middlesex, 88½; Grand Junction, 48¾; Lambeth, 136¾; Chelsea, 68; making a total length of 880 miles.

THE Bill to permit the construction of the proposed "Arcade Railway" under Broadway, in New York, has passed the State Assembly. The plan is to excavate the entire width of Broadway to the depth of 20 ft., and make a new Broadway under the present one, with ample sidewalks, with four tracks for passenger and freight trains, and with an accessible conduit for all the iron pipes, water, gas, &c., now under the street. The upper road is to rest on iron girders, sustained by brick arches covered with concrete, asphalte, and sand, on which the pavement is to be laid.

COLONEL COLTON, commanding the Quebec Citadel, successfully broke the ice gorge on the St. Lawrence River the week before last, by means of gunpowder explosions. The gorge extended for several miles along the river, being jammed at the narrows until it was some 35 ft. thick. Here several shafts were bored and filled with charges of 300 lb. each, which were exploded by electricity. This treatment loosened the ice, and the tide is now cleaning the harbour. The possibility of opening the Montreal port earlier hereafter has thus been demonstrated.

A COLOSSAL BRONZE STATUE.—A great national statue of Germania, which is to be erected at Niederwald, near the Rhine, to commemorate the victory of Germany in the late Franco-German War, is now in process of being cast in separate pieces at Munich, and the head and several other parts have already been collected. Some idea of the magnitude of this work may be gathered from the fact that the total weight of the metal used will amount to 45 tons. —*Engineering.*

Reviews.

LANTERN READINGS.*

THE VOYAGE OF THE *Challenger.*

WE are glad to see that the series of biological lantern slides, planned by Mr. W. Lant Carpenter and Dr. Andrew Wilson, has now been prepared by Mr. York. The series of lectures to be illustrated by the slides includes Foraminifera, Radiolarians, Siliceous Sponges, Crinoids, Echinoderms, &c. We have before us one of the biology series, "The Voyage of the *Challenger*." It is intended to be read by amateur lecturers, and Mr. Carpenter gives excellent instructions for such reading. At the right places in the reading the letter B is marked for the bell-signal to the operator to change the slide. Mr. Carpenter thinks the best signal of all to be the "Invalid Electric Bell," the metallic gong of which has been replaced by a silent wooden one, the bell being placed by the lantern and operated by the reader. Our own experience is in favour of a small hand-bell (struck by pushing a hammer, not by shaking); but then that is because we prefer to have no table, but to be free to occupy at will any part of the platform. We should not care to walk up to a table bell, or to the "push" of the Invalid Bell. Those who read lectures have to be near the table all the time, and would probably prefer the arrangement suggested by Mr. Carpenter.

The lecture here printed for amateur reading is full of interest. We are half inclined to think that many would prefer buying this little pamphlet, and afterwards getting the "Depths of the Sea" and "The Atlantic," whence the lantern pictures have been selected, to attending a reading of it, even though illustrated by the lantern and the slides—no doubt excellent—which Mr. York has prepared. But the slides may be used to illustrate lectures other than those merely read by class teachers and the like. Those who have themselves taken part in the work of biological research, can wish for no better subjects than those which Mr. Carpenter has here selected. Lecturers who speak out of the fulness of their interest in these inquiries, must be glad to find such illustrations as they want collected here for them at a moderate price. Without that living interest, lecture-audiences must of necessity dwindle into mere "classes." But it is essential that those workers and thinkers in special branches of science who may wish to impart to thousands the lessons which have impressed and moved themselves, should have the means of properly appealing to the eyes as well as to the ears of their audiences. (*Segnius irritant, &c., &c.*) The oxyhydrogen lantern and photography give them this power, and we rejoice to see that measures are being taken to provide our public teachers with the illustrations their subjects require.

THE ELECTRIC LIGHT.†

THE fact that this work has reached its second edition in the space of two years, demonstrates that it has met with some measure of success. It must not be forgotten, however, that the volume appeared under the most favourable circumstances. There was, in consequence of the stir made by the practical introduction of the electric light, a great demand for electrical information of all kinds, to supply

* "Lantern Readings. The Voyage of the *Challenger*." By W. Lant Carpenter, B.A., B.Sc., &c. (Alabaster, Passmore, & Co., London).

† "Electric Light; its Production and Use." By J. W. Urquhart, Electrician, Author of "Electro-plating," &c. Edited by F. C. Webb, M.I.C.E., M.S.T.E. (Second edition. London: Crosby, Lockwood, & Co.)

which new books were in some cases necessary. Moreover, Mr. Urquhart had made some reputation by his previous works on electro-metallurgy.

The work is unambitious in design, and accordingly no pretence is made to deal exhaustively with the subject. Nevertheless, it is difficult to perceive the reason animating the author to exclude all reference to electrical measurement, even to definitions of the various units and everyday technicalities, in favour of long descriptions of various batteries, some of which are useless for electric light purposes, and the adoption of which cannot fail to terminate in disaster and disappointment. Our difficulty is to discover for what special class of readers the work is intended. If for electricians, the work is somewhat feeble; if for amateurs, there is a great deal that can in no way interest them. If on the other hand, as indeed seems most probable, the work is intended to be a sort of handbook for professional men: architects, builders, gasmen, vestrymen, and so forth, the general arrangement appears to have been sadly cared for. This latter class of readers could have well spared the greater part of the 44 pages devoted to batteries, while the information about machines and lamps is far too scanty to be of much practical use. Meagre also is the information upon general construction, and a telegraph lineman would be justified in smiling at the picture of the "Britannia" joint.

Secondary batteries are summarily dealt with in four pages. The chapters on magnets and dynamo machines contain good and generally reliable information, the fault being in the choice and arrangement of matter. Machines which are now out of date, and which, when made, involved no new or important feature, are allowed ample space; while more modern, and at the same time more important ones are dismissed with two or three lines and a reference to some other source of information. Thus of the Gulcher machine, which is probably one of the best in the market, all that is said is:—"This machine bears some resemblance to the Brush apparatus. It will be found described in the *Electrician*, of Oct. 29, 1881. One machine develops an electro-motive force of 70 volts, the other of 2,000." It is pleasing to notice that the Ferranti (spelt Farranti on every occasion) comes in for a share of attention, but it would have looked better had the author refrained from making so many advertising observations on this and other dynamos.

In the seventh chapter, containing "general observations on machines," we are told that "if there is jumping or flickering of the light, the carbons are bad, or the same defect may be caused by the engine not having a sufficiently sensitive governor to keep up a steady motion." This is true, so far as it goes; but surely the lamp itself has something to do with steadiness, otherwise whence is the perfection of the Fyfe-Main lamp (which, by-the-way, does not meet with any attention at the hands of Mr. Urquhart)? Some interesting information concerning the history of the construction of incandescent lamps is imparted, although a slight error or two still exists. Such, for example, as the resistance of a Swan lamp, which is stated to be 150 ohms when hot and 250 ohms when cold, or about five times the actual resistances. A work on the electric light without the description of a single meter is a somewhat anomalous phenomenon, and it is to be hoped that, should a third edition be issued, some attention will be devoted to this branch of the subject. The paper and printing are good; the diagrams, too, are highly commendable, if we except one or two of them for bad perspective (as in the illustration of Ladd's machine).

On the whole, the work is very readable. It is infinitely superior to the work on "Electromotors," by the same author, and will doubtless hold a place in the literature of electrical science for some time to come.

THE FACE OF THE SKY.

FROM JUNE 22 TO JULY 6.

BY F.R.A.S.

THE sun still continues to develop interesting little groups of spots, as well as faculæ, &c. (at less frequent intervals, however, than of late) and should hence be observed with the telescope whenever he is visible. The aspect of the stellar vault will be found depicted on Map VI. of "The Stars in their Seasons;" but, as we remarked a fortnight ago, there is no real night, during the period over which these notes extend, in any part of the United Kingdom. As far as planets are concerned, the sky is a practical blank for the observer. Nor do any occultations of stars by the moon occur during our specified period. Her age on June 22nd at noon is 17·2 days, and, pretty obviously, on July 4th, 29·2 days. At noon on July 5th her age will be 0·9 day, and, of course, 1·9 on the 6th. Hence she will be out of the reach of the ordinary observer after the night of the 25th. On the 22nd she is in Sagittarius, passing into Aquarius during the afternoon of the 23rd. She continues in that constellation during the whole of the 24th and the greater part of the 25th, travelling into Pisces before noon on the 26th. She remains in Pisces during the 27th and 28th; and about 11 a.m. on the 29th will be found in that region of the sky where Pisces, Cetus, and Aries are conterminous. She is in Aries during the 29th and a good deal of the 30th, travelling into Taurus about 2 a.m. on July 1. There she remains until noon on July 3rd, when she crosses the boundary into the northern part of Orion. Traversing this in the course of the next twelve hours, we find her at midnight in the confines of Gemini. She continues in Gemini until 3 p.m. on the 5th, at which time she moves into Cancer, where we leave her on July 6th.

M. BOUSSINGAULT has recently presented to the French Academy a communication on the matter diffused or suspended in the air at great elevations. He has examined samples of the rain and snow which fell on the Alps from 1859 to 1865, and has found nitric acid varying from 0 to 0·69 mgs. per litre of water examined. The sample containing the largest amount of nitric acid also contained 0·3 mgs. of ammonia. He intends soon to compare the electrical condition of the northern and southern hemispheres, which condition probably affects the amount of nitrogen compounds present in the air and even in the soil. The writer also, says the *Journal of the Society of Chemical Industry*, notes the fact that hailstorms may occur in very elevated mountain regions, he having experienced one in the province of Riobamba at a height of 5,000 mètres above the sea level.

ALLOYS of metals are often difficult to make and very small quantities greatly affect alloys. The presence of $\frac{1}{30000}$ of a pound of antimony in a pound of melted lead increases the rapidity with which the lead oxidises and burns. Lead which contains more than $\frac{1}{14000}$ of its weight of copper is unfit for the manufacture of white lead. *Der Techniker* says gold with an alloy of $\frac{1}{2000}$ of lead is extremely brittle. Copper with $\frac{1}{2}$ per cent. of iron has only 40 per cent. of the electric conductivity of pure copper. Nickel was regarded as a metal which could be neither rolled, hammered, nor welded, until it was found that the addition of $\frac{1}{1000}$ of magnesium, or $\frac{3}{1000}$ of phosphorus, makes it malleable. Some varieties of cast steel are exceedingly brittle, but the addition of $\frac{1}{12}$ of 1 per cent. of magnesium makes them malleable. At the Paris Exposition of 1878 a great difference was found in the toughness of sheets which were made of Swedish puddled iron. The only difference which chemical analysis showed was that the good plates contained $\frac{20}{100000}$, and the bad $\frac{21}{100000}$ of phosphorus.

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"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

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SINGLE VISION.

[846]—Your correspondent, "Single Vision," in his very interesting letter, correctly describes his own case as being one of extreme disparity of focus between the two eyes. I do not recollect, in all my experience of thirty years, such an extreme case.

I find it is very seldom that, with such extreme disparity of focus, the person can bear the focus being made equal by means of lenses, but in some cases they can do so; and I have visited a case within the last few days in which the person wears a convex lens of 16″ focus on the left eye, and 40″ on the right eye, with great comfort and satisfaction.

Strangely enough, the one point on which your correspondent considers that he may speak with confidence, he may be mistaken in. He is of opinion that "two well-defined images of different dimensions will not coincide and coalesce." Now, if any person having equal vision will take an ordinary spectroscope and place on one side of it, in the centre of the field of view, a bronze-copper halfpenny, and on the other side, in the centre of the field of view, a bronze-copper pennypiece, although the two images given through the lens will differ very greatly in size, a person using the spectro will see an image clearly defined midway between the size of the two coins.

I have got many persons to make this experiment, and in every case with the same results.

From a knowledge of this fact, I ventured upon the prediction that if two discs of colour exactly complementary to each other could be presented one to each eye, the resulting image seen by the observer would be white.

Mr. Stevenson, a member of the Council of the Royal Microscopical Society, some time afterwards produced such discs by means of polarised light, and the result was as I had predicted.

JOHN BROWNING.

[847]—I marvel somewhat that when correcting a mistake made by "Single Vision," in his letter in KNOWLEDGE No. 84, p. 348, you did not also correct the very great mistake in the last sentence of his letter. That sentence, being followed immediately by your note, is virtually endorsed by your silence respecting it, and will mislead dozens of those readers of KNOWLEDGE who are as unacquainted with the elements of optics as "Single Vision."

SINGLE VISION, No. 2.

["No. 2" is quite right; the mistake should have been corrected. Double vision does result, but not because of unequal magnifying, yet the magnifying is unequal.—R. P.]

RATIONAL DRESS.

[848]—I have read with interest all that has been said in your paper about woman's dress, and have been induced by it to try the new style. I am delighted with the result, and would on no account go back to petticoats and stays. As there seems to be a variety of opinion as to what one ought to wear, I will give full details of my costume: flannel combination without band; divided skirt; thin linen body, to the waist of which is buttoned the dress skirt; dress body; stocking suspended from the broad, close-fitting belt of the divided skirt—which belt I consider essential to the comfort of any one leaving off stays for the first time, as it gives such a feeling of support to the body. I wear the same fashionable dresses as I have been accustomed to (frilled, furbelowed, and steeled), and only one lady (and I told *her*) knows that I have altered my undergarments. The keenest feminine eyes have noticed only the greater ease with which I take long walks, and my healthier appearance. I am twenty-two years old and vain enough not to wish to make an object of myself. I assure all women they can try the new dress for themselves without any one being the wiser.

PEDESTRIENNE.

[We are much obliged to "Pedestrienne" for her letter. "A Lady," to whom we have shown it, says it agrees with her experience in all respects.—R. P.]

A FEW OBSERVATIONS ON HEAT.

[849]—Mr. Davidson says no attempt has ever been made to explain the nature of the product resulting from multiplying specific heat by temperature, so far as he knows. In the "Transactions Roy. Soc. Edin., XX.," the late Professor Rankine clearly explained this thirty years ago. The product is not "momentum," but "energy," and is proportional, not to the velocity, but to the square of the velocity. Mr. Davidson should also have written "absolute temperature" for "temperature." He talks of the momentum of a "single molecule," whereas the statistical method introduced by Clausius and Maxwell should have been adopted, and the "mean square" velocity ascertained. He talks of the "method of mixture." Does he mean the method of mixture of solid substances? He says the specific heat of water is exactly twice that of the vapour. But he takes no note that the latter varies with temperature and pressure. And at 212° Fah., and 14·7 lb. per square inch, the specific heat of steam to water is as ·37 to 1—not double. See McFarlane Gray, in *Phil. Mag.*, May, 1882.

In the concluding paragraph, Mr. Davidson says temperature seems to correspond to space; whereas Rankine, Clausuis, Thornton, Tait, and Maxwell, show that it *is* kinetic energy, not that it *corresponds* to it. Mr. Davidson concludes by explaining the reflection of light by the exploded corpuscular theory! T. J. DEWAR.

CONSANGUINEOUS MARRIAGES.

[850]—In reading your report of Dr. Cameron's paper on the above subject in its relation to deaf-mutism, I was reminded that I had lately seen a number of cats and kittens which were nearly all quite deaf. In rearing the animals in question no care was taken to avoid in-and-in breeding; in fact, to keep the breed pure, quite an opposite plan was adopted, and they are all descendants of one pair obtained some twenty or thirty years ago. The result bears out in a remarkable degree the conclusion arrived at by Dr. Cameron in the paper referred to. R. S. T.

AN ODD MISPRINT.

[851]—Your item in KNOWLEDGE for April 27, on the blunders of compositors, recalls an experience of my own, some two years since. My right arm was temporarily disabled. I commonly announce the topic of my Sunday discourses in our daily newspaper of Saturday. Being unable to write, I stepped into the business office of the paper, and asked a clerk to write a notice for me, saying that my subject on Sunday morning would be "Cæsar's Things, and God's." Judge of my surprise on reading, a few hours later, that I would speak on "Corsairs, Thugs, and Gods!" And I abhor sensationalism in the pulpit! W. G. HASKELL.

LANDRAILS.

[852]—Every observant country rambler cannot fail to have noticed the unusual numbers of landrails (*Crex pratensis*) that are to be met with. The voice of this meadow bird, softened by distance, is one of the most characteristic of our rural charms; but when one's ears are assailed on all sides with the monotonous cry of this bird, the usual pleasant effect is assuredly marred. From different parts of our island I have heard of their phenomenal abundance; indeed, they seem to be a sort of affliction this year—they literally and positively swarm. Did we live in the times and country of Moses and Pharaoh, I should be decidedly inclined to attribute their numbers to an eleventh plague. Out in the fields one hears naught but their abominable crake-crake, crake-crake, and towards dusk their persistency is something marvellous. The very air seems saturated with their outrageous clamouring, and the otherwise poetic gloaming becomes very prosy indeed. I am here just half-a-mile from the centre of the old Danish burgh of Derby, and yet, with my window open, I can distintly hear the subject of my letter rasping out his harsh song, as if his very life depended on the effort. To my knowledge, this is the first time for years that they have approached the town so near. There is something essentially romantic in the idea of being serenaded, on a moonlight night, beneath one's chamber window; but when the "gay troubadour" turns out to be a saw-voiced, crack-throated

landrail, the romance disappears, and gives place to a very different feeling. A friend of mine in Lancashire has just sent me his bitter experiences of such a trying ordeal. He is a great ornithological enthusiast, but—*non mirabile dictu?*—the most unbounded enthusiasm has its limits. It seems that for several nights in succession his slumbers were disturbed by the unceasing and loud complaint of a wretched corncrake which planted itself on the grass plot directly under his bedroom window, and kept up a continuous unmusical call throughout the dreary watches of the night. For a time, he bore the affliction with the patience of martyrdom; but at length, exasperated beyond all bounds at the audacity and barefacedness of the intruder, he got up and shot it.

What is the cause of the abundance of the bird this year? I cannot look back upon many decades of life myself, but it appears certain that landrails have their periods of maxima and minima, as well as sun-spots. Surely the cause *is* traceable? Probably Mr. Grant Allen could be persuaded to give his opinion on the matter? I can assure you, Mr. Editor, any remarks of his on the point would be most welcome to more than one of your many readers.

Derby, *June 8th*, 1883. T. K. DEALY.

LETTERS RECEIVED AND SHORT ANSWERS.

W. G. HASKELL. Mr. Clodd's valuable papers will be reprinted—probably next fall.—ÆON. (1) The "one" more fully acquainted with the laws and forces of Nature than Newton will, I trust, teach you how to present the higher truth known to you in such a way as to convince Newtonians. (2) The difference between imagining and conceiving, in such cases as you consider, may be thus presented:—To say Newton imagined that attractive forces act by successive impulses would imply that he thought (or at least thought it possible) that they do so. But he thought nothing so absurd. He conceived them to act in that way, as the only possible way of determining the effect of their action. The result he obtained *while that conception was in force* was as incorrect as the conception itself, for it indicated a polygon as the path of the attracted body; but the curve to which that polygon is shown to approximate is the true path, just as the continuous force is the true limit of the force supposed to act by successive small impulses.—WILFRID. I believe the double "t" in "Britt" is intended to indicate the plural,—though in a rather singular way.—G. B. No doubt a large meteor.—W. You cannot properly denote the force of a blow in terms of weight; although a particular spring may be just as much deflected by static pressure as by a blow, the same static pressure would deflect another spring of different quality in different degree than it would be deflected by a blow of the same force. As to the other questions, they belong to the text-book explanations of definitions, &c., and cannot conveniently be answered here.—E. M. H. In Humboldt's "Looks into Nature," the nature of Indian edible clay is, I think, explained; but I am away from books just now.—C. F. HALL. Thanks; but at present have barely space for subjects in hand.—W. HIPSLEY. The longitude is now often determined by lunars. Quite possibly Swedenborg indicated with more or less distinctness the value of the method. But he can hardly have taught Newton, Halley, or Flamsteed anything new on the subject, seeing that one of the special objects for which Greenwich Observatory was founded was the observation of the moon for the express purpose of affording a means of determining the longitude at sea.—E. J. SCOTT. Sixty oranges at 2 for 1d. and 60 for 3 for 1d., are 60 at $\frac{1}{2}$d. each and 60 at $\frac{1}{3}$d. each, or 120 at an average of $\frac{5}{12}$d. each; 120 at 5 for 2d. are 120 at $\frac{2}{5}$d.; and $\frac{2}{5}$d. cannot be considered precisely equal to $\frac{5}{12}$d., fix it how you will. That is the only explanation I can think of, except the statement you ask me to explain, which is in itself sufficient—to wit, 60 at 2 for 1d. and 60 at 3 for 1d. come to 4s. 2d., whereas 120 at 5 for 2d. come to 4s.—F. L. GRENSTED. Letter will appear as soon as possible.—R. E. S. The disadvantage of your optical theory of comets' tails (I suppose 500 have asked my opinion on it) is that it is entirely inconsistent with fact; otherwise it is capital.—W. H. S. MONCK. What *is* matter? Never mind.—C. T. DAVY, T. WELTON, J. GREEN, M. E., E. DELBRÜCK, W. OXLEY, C. NORRIS, D. DRAPER, W. MILLER, H. PENRITH, W. THOMAS. Excuse delay in acknowledgment. If you only knew how the correspondence arrears are growing.—ROB. THOMSON. The theory of a primitive impulse on the planets is not now held by any scientific man.—J. B. If a table were made a mile square, and set with its central part in a perfectly horizontal position, and water were poured on to it so as to cover it (allow a rim, please), that water would be two inches deeper at the middle of the table than at the middle of an edge, and four inches deeper than at the corners.—A. KITSON. I wrote my "Elementary Astronomy" (1s. 6d.) for the purpose you mention.—C. H. HARDING. Know of no way but writing to secretary of the R. Institution. It was the plan I followed.—WM. CLARK. Birds have often been observed to go to roost during total eclipse; but it is never anything near as dark as night.

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By RICHARD A. PROCTOR.

PART IV.

WE have hitherto taken theorems involving *exact* results as our illustrative examples, and we have seen that to such theorems, analytical or synthetical methods, or combinations of both, are applicable with equal advantage. We shall presently discuss other propositions of this sort, and of greater complexity. But we must now notice the fact that in certain propositions we have no choice as to the method of solution. This is almost always the case with theorems involving *general* results, and with *problems* properly so called—that is, with propositions in which something is required to be *done*. Propositions of the former class require the synthetical, propositions of the latter class the analytical method. But, of course, neither of these rules holds, necessarily, in problems of great simplicity, in which only one or two steps separate the *data* from the *quæsitum*.

We begin with an instance of this sort—viz., a very simple theorem in which the relation to be established is general. Suppose we have to prove the following proposition:—

Ex. 3.—*Let A B C, Fig.* 8, *be an isosceles triangle, A B being equal to A C: produce A B to D, and join D C. Then shall D C be greater than B C.*

There is only one proposition in Euclid which deals with the inequality of two sides of a triangle—viz., prop. 19, Bk. I. It naturally occurs to us, therefore, to apply this proposition. We have to show that D C is greater than B C, and we know from Euc. I., 19, that if D C *is* greater than B C, then the angle D B C is greater than the angle B D C. Now, our figure shows us D B C as an obtuse angle, and a moment's consideration shows that D B C is necessarily obtuse. For this requires that A B C should

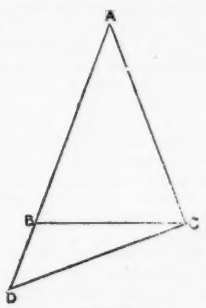


Fig. 8.

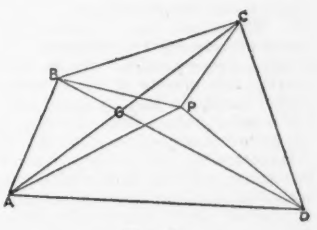


Fig. 9.

be necessarily acute. But the angle A B C is equal to the angle A C B (Euc. I., 5), and two angles of a triangle being less than two right angles (Euc. I., 17), each of these angles must be less than one right angle. Therefore A B C is acute, and its supplement, D B C, is obtuse. B D C is therefore acute, and D C greater than B C.

We will next try a proposition slightly more difficult.

Ex. 4.—*Let P, Fig.* 9, *be a point which does not lie on either diagonal of the quadrilateral A B C D; then shall the sum of the four lines A P, B P, C P,* and *D P be greater than the sum of the diagonals A C, B D.*

Here it would serve us nothing to begin analytically by *supposing* A P, B P, C P, and D P to be, together, less than A C and B D together. It would be impossible to deduce anything from a general relation of this sort. We must, therefore, proceed synthetically.

Let O be the intersection of the lines A C, B D.

Then we might first be struck by the fact that D P and A P are together greater than A O and O B together (Euc. I., 21). But then we notice that, on the other hand, C P and P D are together less than C O, O D together. So that unless we can show the former *excess* to be greater than the latter *defect*, we have proved nothing to our purpose. This method does not seem promising. Nor does it seem likely to be useful to take B P, P C together and then A P, P D together, comparing these pairs, respectively, with B O, O C together and A O, O D together.

Let us try taking alternate lines together, namely, B P, P D, and A P, P C. We at once see that B P, P D are together greater than the diagonal B D; and that A P, P C are together greater than A C. Hence, P A, P B, P C, and P D are together greater than A C and B D together.

(To be continued.)

Our Chess Column.

By MEPHISTO.

THE TOURNAMENT.

Zukertort has concluded his part in this great contest with a turn of fortune against him. On Wednesday, the 22nd, he had to meet Mackenzie, and, having arrived at an apparently won position, he made a blunder, which lost him the game. Thursday he played Sellman in very weak fashion, of which the latter took proper advantage, and by good play and making the best of the position he won. On Friday Zukertort played Mortimer. He played the Evans Gambit, which Mortimer accepted, playing the Compromised Defence. Despite the fact that Zukertort knows more about this opening than any other player, his opponent succeeded in getting fairly through the opening, and, as may be seen from the game, a well-played game resulted, in which Zukertort, by some fine manœuvres, arrived at a winning position; but the feeling of irresponsibility under which this game was played prompted him to seek a speedier termination of the game than he was justified in doing by the sacrifice of the Rook. Mr. Mortimer, defending himself with great skill, managed to score a victory highly creditable to himself. In reference to the nonsensical remarks anent Zukertort's reverses in the daily press, we, for our part, think it far more a matter of surprise that Zukertort held out to make the most wonderful score of 22 games, only to break down at the last moment, when success was of no more consequence to him.

Far more remarkable was the defeat of Steinitz by Rosenthal. Everything depended on the loss of a game to Steinitz, as it might deprive him of second place. Nevertheless, he overlooked a very obvious win, and lost. We give the position in our present issue. Despite this blemish, we think the game one of the very finest games played in this tournament, and it does credit to Rosenthal.

Blackburne defeated Winawer on Wednesday and Bird on Saturday, advancing his score to 16½. He met Steinitz on Friday, and we think we are right in stating that this game was a fight for second prize between these two old antagonists. Steinitz score was 15, while Blackburne stood at 15½. Blackburne, as second player, adopted the French Defence, to which Steinitz replied with P to K5. Blackburne played indifferently, the result being to enable Steinitz to support his advanced Pawn by P to Q4 and KB4, and obtain a strong position. Blackburne fought an uphill fight very bravely, and, in spite of his succeeding in capturing a dangerous passed pawn, he lost, by superiority of forces, a game which exhibits nothing apart from the winning process. All other players are quite uncertain as to what will be their ultimate position.

On Saturday Tschigorin stood at 15, he having only Mortimer to encounter, and also to play off a draw with Rosenthal. He drew with Rosenthal for the second time, and had some fair chance of coming in fourth, which will probably be reached by a score of 16½; but, lo and behold! he was defeated by Mortimer on Monday. Speaking from our own experience, as well as from the above case, we think that to some excitable natures the knowledge of standing in great need of a certain object will render its attainment far more difficult than it would have been under ordinary circumstances. This defeat renders Rosenthal's probable position of fourth more secure, especially as he defeated Sellman on Monday, his score being 14, and 4 to play; and another rival—Mackenzie—being that day beaten by Steinitz. Mason defeated Noa on Monday, Sellman on Saturday, but suffered a defeat by Tschigorin on Friday. He now stands at 15½, but he has to meet Steinitz yet, therefore his chance is not a very good one.

On Tuesday Steinitz defeated Mason in a very fine and decisive game, which will rank as one of the masterpieces in the Tournament. Considering the amount of bad luck Steinitz had to contend with, his score of 19 is very creditable. He takes the second prize of £175. Tschigorin avenged his defeat by beating Rosenthal in a Ruy Lopez. After the latter had played P to QR3, and later on QKt4, Tschigorin attacked the Queen's side in a novel manner, by P to QR4, and soon obtained a good game. He has finished with a score of 16, and is awaiting events. English and Mackenzie drew for the third time, and therefore count ½ each. Winawer beat Sellman.

The following players have completed their score:—

Zukertort	22	Mason	15½	Noa	9½
Steinitz	19	Winawer	13	Sellman	6½
Tschigorin	16	Bird	12	Mortimer	3

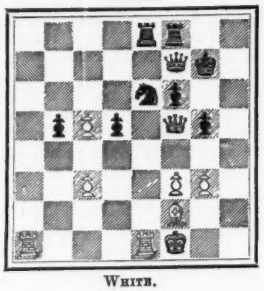
The remaining players are Blackburne, with 16½, having to play with English and Rosenthal; Rosenthal, 14, having to play English, Blackburne, and Mackenzie; Mackenzie, 14½, having to play Rosenthal; English, 13½, having to play Rosenthal and Blackburne.

It will be seen that English is eighth. Either he or Mackenzie will, therefore, not take a prize, and the others will probably rank as follows:—Blackburne third, Tschigorin fourth, Rosenthal and Mason fifth and sixth, English or Mackenzie seventh.

Wednesday.—Blackburne drew with English; Mackenzie (probably) beat Rosenthal.

Position of the game between STEINITZ and MACKENZIE.

MACKENZIE.
BLACK.

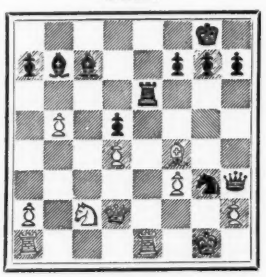


WHITE.
STEINITZ.

White played.			
33. R to R6	Kt to B2	38. Q to Kt6	K to K2
34. R takes R	Q takes R	39. B to B5 (ch)	K to K3
35. R to R7	Q to Kt sq	40. P to Kt4	R to B sq
36. P to B6	R to B2	41. Q to B5 (ch)	K to B2
37. B to Q4	K to B sq	42. Q to R7 (ch)	Resigns.

The following position occurred in the game between STEINITZ and ROSENTHAL:—

ROSENTHAL.
BLACK.



WHITE.
STEINITZ.

Rosenthal continued with the beautiful move of

	Kt to K5
R takes Kt	P takes R
B takes B	P takes P
R to Q sq	

(If Q to B2, then P to KR4 wins.)

	R to Kt3 (ch)!
B to Kt3	R takes B (ch)!
P takes R	P to B7 (ch)!
K takes P	Q to Kt7 (ch)
K to K3	Q to B6, mate.

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